3-D Spatiotemporal Mode-Locking

Laser technology confines light inside a resonator containing a gain medium, a material with quantum properties that can amplify light. As laser resonators are generally far larger than the wavelength of light, lasing inside their cavities can occur in a wide range of patterns, which are known as modes. [16]

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University Professor of Applied Physics Stephen Arnold and his team at the New York University Tandon School of Engineering have made a discovery that could lead to Star Trek-like biosensor devices capable of flagging the barest presence in blood of a specific virus or antibody, or protein marker for a specific cancer; or sniffing out airborne chemical warfare agents while they are still far below toxic levels. [12]

Lead researcher Dr Jonathan Breeze, from Imperial's Department of Materials, said: "This breakthrough paves the way for the widespread adoption of masers and opens the door for a wide array of applications that we are keen to explore. We hope the maser will now enjoy as much success as the laser." [11]

Japanese researchers have optimized the design of laboratory-grown, synthetic diamonds. [10]

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A UNSW Australia-led team of researchers has discovered how algae that survive in very low levels of light are able to switch on and off a weird quantum phenomenon that occurs during photosynthesis. [8]

This paper contains the review of quantum entanglement investigations in living systems, and in the quantum mechanically modeled photoactive prebiotic kernel systems. [7]

The human body is a constant flux of thousands of chemical/biological interactions and processes connecting molecules, cells, organs, and fluids, throughout the brain, body, and nervous system. Up until recently it was thought that all these interactions operated in a linear sequence, passing on information much like a runner passing the baton to the next runner. However, the latest findings in quantum biology and biophysics have discovered that there is in fact a tremendous degree of coherence within all living systems.

The accelerating electrons explain not only the Maxwell Equations and the Special Relativity, but the Heisenberg Uncertainty Relation, the Wave-Particle Duality and the electron's spin also, building the Bridge between the Classical and Quantum Theories.

The Planck Distribution Law of the electromagnetic oscillators explains the electron/proton mass rate and the Weak and Strong Interactions by the diffraction patterns. The Weak Interaction changes the diffraction patterns by moving the electric charge from one side to the other side of the diffraction pattern, which violates the CP and Time reversal symmetry.

The diffraction patterns and the locality of the self-maintaining electromagnetic potential explains also the Quantum Entanglement, giving it as a natural part of the Relativistic Quantum Theory and making possible to understand the Quantum Biology.

Contents

Author: George Rajna

Preface

We define our modeled self-assembled supramolecular photoactive centers, composed of one or more sensitizer molecules, precursors of fatty acids and a number of water molecules, as a photoactive prebiotic kernel system. [7]

The human body is a constant flux of thousands of chemical/biological interactions and processes connecting molecules, cells, organs, and fluids, throughout the brain, body, and nervous system. Up until recently it was thought that all these interactions operated in a linear sequence, passing on information much like a runner passing the baton to the next runner. However, the latest findings in quantum biology and biophysics have discovered that there is in fact a tremendous degree of coherence within all living systems. [5]

Quantum entanglement is a physical phenomenon that occurs when pairs or groups of particles are generated or interact in ways such that the quantum state of each particle cannot be described independently – instead, a quantum state may be given for the system as a whole. [4]

I think that we have a simple bridge between the classical and quantum mechanics by understanding the Heisenberg Uncertainty Relations. It makes clear that the particles are not point like but have a dx and dp uncertainty.

A theoretical approach to understand the mechanisms of 3-D spatiotemporal mode-locking

Laser technology confines light inside a resonator containing a gain medium, a material with quantum properties that can amplify light. As laser resonators are generally far larger than the wavelength of light, lasing inside their cavities can occur in a wide range of patterns, which are known as modes.

Past physics studies have found that possible lasing patterns (i.e., modes, or combinations of modes) compete with one another for energy and that the laser then selects the pattern that minimizes the loss of energy. This 'selection process' could be loosely compared to natural selection as described in Darwin's theory of evolution, where the members of a species that adapt best to their environment tend to survive and produce more offspring. Similarly, the patterns of lasing (i.e., modes) that make the best use of their energy resources end up dominating the others.

Shortly after lasers were invented, physicists started realizing that this 'competition' between modes can be controlled in a way that causes the technology to produce remarkably short pulses, a phenomenon that is now known as mode-locking. This synchronization phenomenon involves many of the laser's modes oscillating together, forming pulses of several femtoseconds (10^{-15} ss).

Mode-locking takes place when laser designers introduce an element into the laser's cavity that enforces that the lasing pattern that uses energy more efficiently turns into the pattern that maximizes the peak intensity of the laser's electric field. This pattern turns out to be one in which many modes lase simultaneously with a synchronized phase. Since its discovery, mode-locking has been exploited in many devices, including high-field optics and frequency combs.

So far, this synchronization phenomenon has almost always been described as the self-organization of light in a single dimension, that of time. Nonetheless, it could also potentially be understood as a three-dimensional phenomenon, manifesting itself in both time and space.

Researchers at Cornell University, working with a team of external collaborators, have recently introduced a theoretical approach that could help to gain a better understanding of 3-D spatiotemporal mode-locking. Their theory, presented in a paper published in *Nature Physics*, builds on a series of observations gathered in their previous studies.

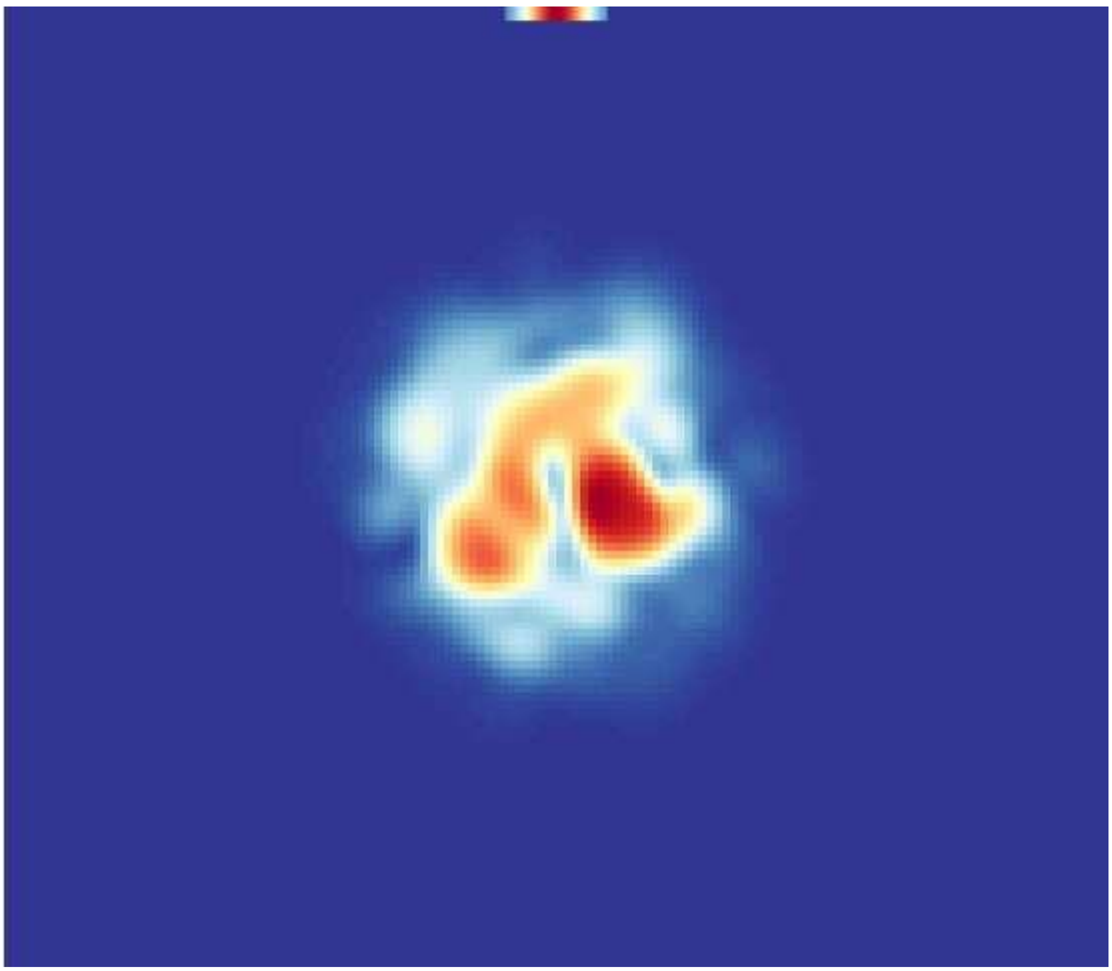


Image of the beam produced by the laser in the researchers' experiments, showing how complex the solution to the natural optimization problem that the laser solves can be. Credit: Wright et al.

"In 2017, I discovered that mode-locking was far more general than was appreciated before," Dr. Logan G. Wright, one of the researchers who carried out the study, told Phys.org. "Rather than being possible only in very constrained laser designs, I found that mode-locking could occur even in 'bad' laser cavities with many complicated modes. This general mode-locking process is called spatiotemporal mode-locking."

Dr. Wright's observation of spatiotemporal mode-locking surprised many researchers within the physics community, as it suggested that most previous theories about the phenomenon were oversimplified. His work essentially revealed that laser physics may be far more 'creative' than what most physicists expected.

"In this new study, we wanted to understand just how adaptive the laser could be in finding complicated solutions to this optimization problem and if there was a more general way to understand how lasers solve this problem," Dr. Wright said. "In other words, is it still just making the best use of energy or is there more going on?"

Dr. Wright and his colleagues came up with a new theoretical approach called 'attractor dissector," which could help to better understand how the spatiotemporal mode-locking phenomenon reported in their previous work can lead to a "Darwinian'-like selection among lasing patterns. After verifying their theory by collecting detailed measurements, the researchers showed that the fairly complex patterns of light enabled by spatiotemporal mode-locking can generally be reconciled with the modes' selection pressure and their need to use energy efficiently.

"In short, we took a rigorous mathematical description of the laser and considered it as an optimization problem that the laser is trying to solve," Dr. Wright explained. "This mathematical description is ridiculously complicated to deal with in general, but in extreme cases, we were able to reduce the optimization problem to the optimization of a single variable. At least in these cases, we could show that the laser seems to be working to maximize energy efficiency."

The theory proposed by Dr. Wright and his colleagues provides a model for each of the different types of 3-D pulses they observed in spatiotemporal mode-locking. This can in turn help to identify the intracavity effects responsible for their formation and stability.

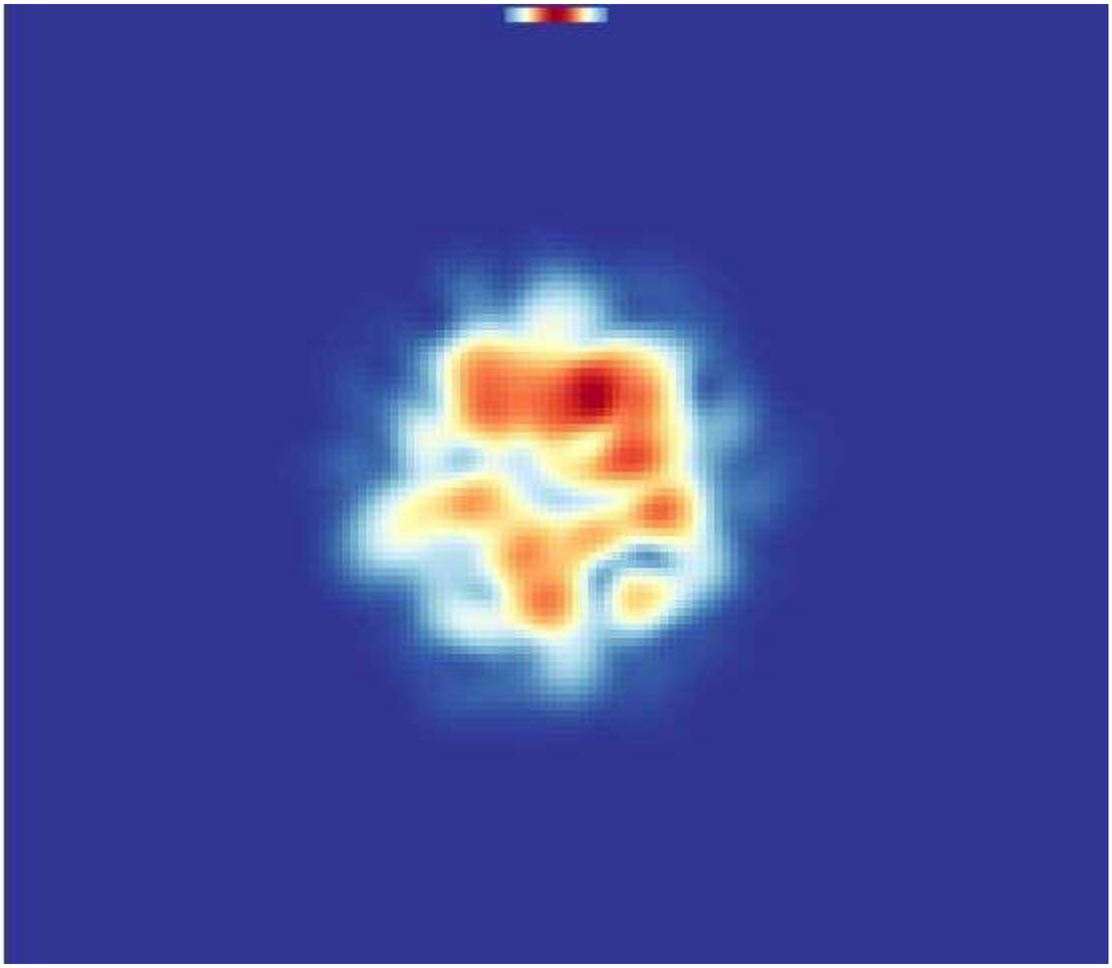


Image of the beam produced by the laser in the researchers' experiments, showing how complex the solution to the natural optimization problem that the laser solves can be. Credit: Wright et al.

Overall, the findings gathered by Dr. Wright and his colleagues are aligned with the previous understanding of mode-locking, yet they suggest that the phenomenon can be of a far more creative and complex nature than what was initially thought. The researchers also showed that previous intuitions regarding mode-locking do not always hold, particularly when a problem is very complex.

"Multimode lasers may be a place where experimentalists can study self-organization and Darwinian-like competition in settings that are very complex (far beyond what can be simulated on conventional computers), but that nonetheless can be controlled (unlike most populations of animals in nature, for example)," Wright said. "Thus, they may be a good place for physicists to understand how natural complex systems self-organize."

Using their theoretical approach, Dr. Wright and his colleagues were able to identify several different types of 3-D spatiotemporal mode-locking, all of which have no analogues in a single dimension. Their results could thus help to uncover more complex forms of coherent light, which may have important implications for both research and technological development.

"Lasers have been monumentally important in enabling scientists to push frontiers of measurement and experimentation: in physics and chemistry, most Nobel prizes rely on a measurement or experimental technique that has been enabled by a particular laser capability," Dr. Wright said. "So while we can't be too specific yet, we are excited about what new laser capabilities may ultimately enable for scientific (and industrial) applications."

By explaining how laser technology works in complex regimes, the approach and observations presented by Dr. Wright and his colleagues could pave the way to the development of new types of lasers with different capabilities and features. The researchers' theory could also improve the current understanding of how complex physics amounts to natural optimization, potentially informing the design of new optimization and artificial intelligence algorithms.

"At NTT Research, in the Physics and Informatics Laboratory, I am now working to understand how natural physical systems perform computations and how we can harness these computations," Wright said. "Within this goal, the multimode laser's ability to solve complex optimization problems makes it a prime experimental system, and we are actively working to design related optical machines that harness this capability to perform simulations and to solve complex combinatorial problems. An important step that I am currently focusing on entails trying to understand the possible role that quantum effects can have on natural computations." [16]

A sound boost to extreme laser performance

Diamond is a particularly interesting material for this type of laser for two key reasons. Its high thermal conductivity means it is possible to make miniature lasers that simultaneously have high stability and high power. The speed of sound is also much higher compared with other materials. This gives the laser a secondary ability to directly synthesize frequencies in the hard-to-reach millimeter wave band.

In an article published in *Applied Physics Letters Photonics* this week, the researchers show that the light-sound interaction is particularly strong in diamond, and have demonstrated the first bench-top Brillouin laser that uses diamond.

This result is a breakthrough as it provides a highly practical approach to Brillouin lasers with a greatly increased range of performance. In contrast to earlier Brillouin lasers, the diamond version operated without having to confine the optical or sound waves in a waveguide to enhance the interaction. This means Brillouin lasers can be more easily scaled in size and with much greater flexibility for controlling the laser properties as well as increasing power.

Diamond provides a new way to begin to exploit the unique properties of Brillouin lasers. Only a very small amount of waste energy is deposited in the sound-carrying material. This leads to a host of features including beam generation with ultra-pure and stable output frequency, the generation of new frequencies, and potentially, lasers with exceptionally high efficiency.

Macquarie University's Rich Mildren says "This development provides a new pathway towards high power lasers that are extremely efficient and have exquisite frequency properties such as low-phase noise and narrow line width. These are properties needed for applications that demand the highest standards of noise-free frequency properties, like ultra-sensitive detection of gravitational waves or manipulating large arrays of qubits in quantum computers."

Another ground-breaking outcome is that the diamond can synthesize very pure frequencies beyond the microwave band. As a consequence of the very high speed of sound in diamond—a dashing 18 km/s—the frequency spacing between the input pump beam and the laser line is many times higher than in other materials. This property can be used to generate frequencies in the millimeter wave band (30-300 GHz) using a technique called photo-mixing. Brillouin laser synthesis of these frequencies is important because there is an intrinsic mechanism that reduces the frequency noise to the levels needed by next-generation radar and wireless communication systems. This has been a major challenge for electronics or other photonic-based generation schemes.

The work so far has quantified the strength of the light-sound interaction in diamond, a fundamental parameter for predicting future design and performance. It also demonstrated a practical device with over 10 W of power.

Dr. Zhenxu Bai, lead Ph.D. student on the project, says "We can now begin to think about the design of Brillouin lasers in a new way, rather than as a phenomenon limited to small guided wave structures or as a detrimental effect in fiber lasers."

The authors are concentrating their future work on expanding the range of laser capability by demonstrating lasers with the higher levels of frequency purity and power needed to support future progress in quantum science, wireless communications and sensing. [15]

Laser ultrasound enables diagnoses at a distance

Fully contact-free laser ultrasound (LUS) imaging has been demonstrated in humans by researchers at Massachusetts Institute of Technology (MIT), in collaboration with MIT Lincoln Laboratory. Xiang Zhang and colleagues used an infrared laser to generate sound waves at the tissue surface of volunteers' forearms. A second beam detected the propagating sound waves by measuring how the subjects' skin vibrated in response. The technique could be especially useful for imaging where physical contact is not tolerated, such as over wounds and on other sensitive areas (*Light Sci. Appl.* 10.1038/s41377-019-0229-8).

In conventional ultrasound imaging, an array of transducers is pressed against the skin directly or with a coupling gel to help transmit the acoustic waves into the tissue. The method is inexpensive, convenient and produces images in real time, but it has some disadvantages.

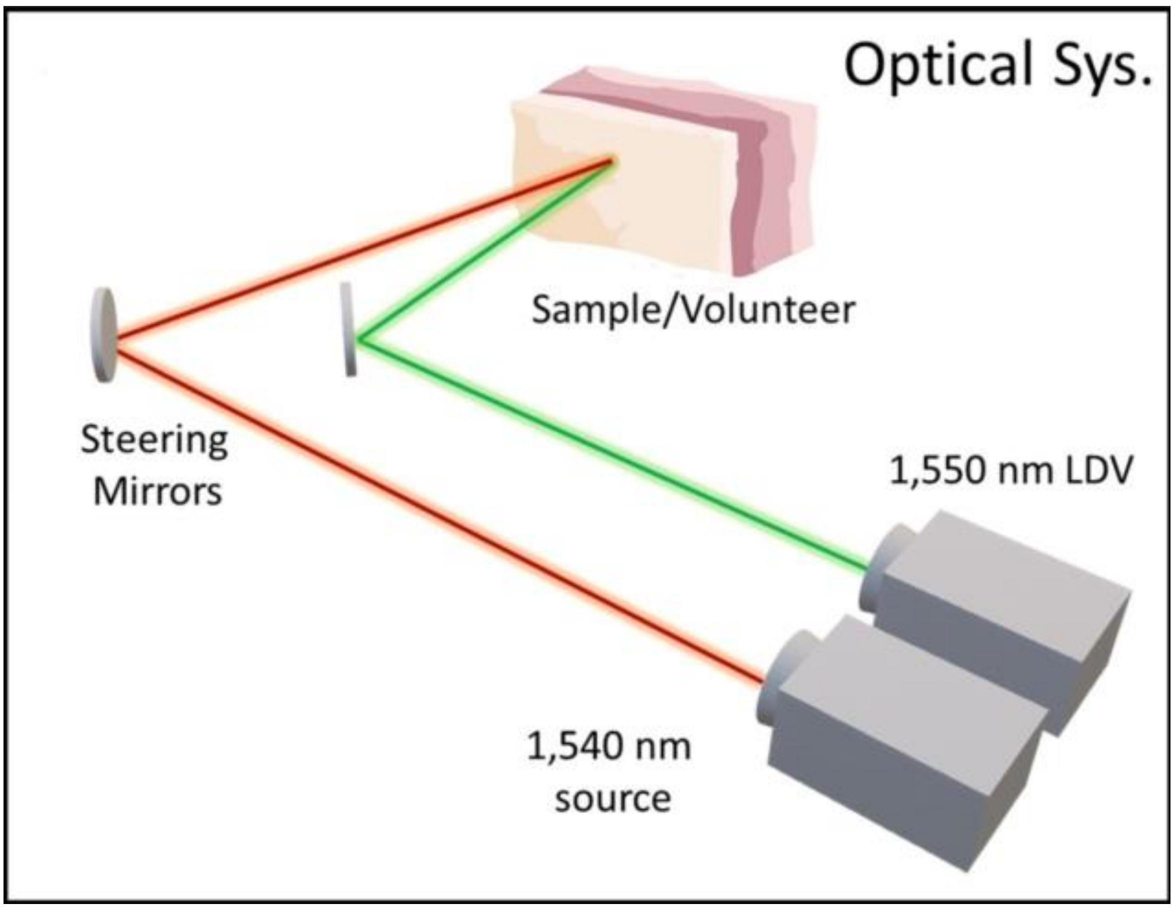
One significant limitation is the pressure that is typically required to maintain acoustic contact between the device and the target tissue. This limitation is exacerbated for contact-sensitive applications where such pressure would be too painful, such as for burn victims or trauma patients.

Another problem is the low degree of reproducibility, due to the fact that the operator usually defines the image orientation and field-of-view by manipulating the transducers manually. This means that patient images acquired at different times are difficult to compare, and treatment or disease progression cannot easily be tracked.

A variation on the technique – ultrasound tomography – addresses the issue of reproducibility, but the solution comes at the expense of convenience, as it involves part of the patient being immersed in a water tank. The problem of physical contact, meanwhile, is partly dealt with by photoacoustic imaging. In this method, the ultrasound pulses are generated within the tissue remotely by a laser, but the reflected signal is detected using conventional transducers on the skin.

LUS could tackle these problems simultaneously by combining a new approach to photoacoustic generation with an optical interferometer, allowing it to create and measure ultrasound waves from a distance. Conventional photoacoustic imaging cannot image deeply since the light is strongly attenuated in the tissue. Rather than seeking a way to increase the laser's penetration, however, in their new approach Zhang and colleagues turned this bug into a feature.

"We actually rely on this high absorption to efficiently generate an acoustic source at the tissue surface, meaning we can convert the maximum amount of light into acoustic energy while maintaining human safety," explains Zhang. "This allows us to image deeper than typical photoacoustics since we don't rely on light to travel through the tissue; only acoustic waves instead."



A simplified schematic of the laser ultrasound system. (Courtesy: Xiang Zhang *et al*)

The team found that they achieved the ideal balance of optical absorption, acoustic power and patient safety using 2 mm-wide, nanosecond laser pulses at wavelengths near 1500 nm. This setup approximates a disk-shaped transducer just beneath the tissue surface, producing a 60° ultrasound beam at 1.5 MHz – towards the lower end of the frequency range typically used for ultrasound imaging.

The researchers tested their LUS technique using a gelatin phantom, *ex vivo* pig tissue and four human subjects, comparing the results to those from a standard ultrasound imager. While LUS could not match the image quality provided by the conventional approach, it still successfully picked out the same soft- and hard-tissue features.

One aspect in which LUS is currently lacking is its inability to deliver results in real time, as images must be reconstructed from sequential single-point measurements. In this respect, Zhang expects the development of the technique to mirror that of conventional ultrasound imaging.

“Looking back historically, medical ultrasound began by sequentially moving a single transducer to form an image – similar to moving a single laser spot in LUS – and eventually scaled toward arrays of hundreds or even thousands of transducers in medical probes today. I believe a similar path is ahead for LUS,” says Zhang.

Progress along this path should be accelerated by a fortunate coincidence: as well as being ideal for LUS, 1500 nm is the wavelength favoured by the telecommunications industry, meaning that both new and mature optical technologies are readily available for translation. Even in its current state of development, however, the technique could find immediate applications where high-quality images are not strictly required, Zhang suggests.

“For now, LUS could be useful in binary measurements where features don’t necessarily need to be resolved at a high resolution; rather, a yes/no measurement is sufficient, possibly for detection of internal bleeding or fractures in painful areas,” he tells *Physics World*. [14]

Diagnosing breast cancer using red light

Optical Mammography, or OM, which uses harmless red or infrared light, has been developed for use in conjunction with X-rays for diagnosis or monitoring in cases demanding repeated imaging where high amounts of ionizing radiation should be avoided. At the OSA Biophotonics Congress: Biomedical Optics meeting, held 3-6 April in Hollywood, Florida, USA, researchers from Milan, Italy, will report an advance in instrument development that increases the sensitivity of OM by as much as 1000-fold.

In 2012, the most recent year for which data is available, more than 1.7 million women worldwide were diagnosed with breast cancer. Many of these diagnoses are made using X-ray mammography. Although standard and widely used, X-ray imaging for breast cancer suffers from both low sensitivity (50-75%) and the use of ionizing radiation that cannot be considered completely safe.

The newly-developed instrument replaces two photomultiplier tubes (PMTs) of existing instruments with an eight-channel probe involving silicon photomultipliers (SiPMs) and a multichannel time-todigital converter. These changes eliminate a time-wasting pre-scan step that was required to avoid damage to the PMTs. In addition to increased sensitivity, the new instrument is both more robust and cheaper.

While X-ray mammography is widely used and is still the recommended method for routine screenings, its use is limited by the patient's age, weight or body mass index, whether or not hormone replacement therapy is being used, and other issues. In addition, its accuracy—particularly when used in younger women—has been called into question. Other imaging techniques, such as MRI and ultrasound, are sometimes suggested, but neither is an effective replacement for X-ray mammography.

Optical imaging methods, on the other hand, have attracted increasing interest for breast cancer diagnosis since both visible and infrared light are highly sensitive to blood volume and oxygenation. Tumors are characterized by a high volume of blood due to the increased vascularization that occurs as tumors grow. OM can be used to measure blood volume, oxygenation, lipid, water and collagen content for a suspicious area identified through standard X-ray imaging. Collagen measurements are particularly important since this species is known to be involved in the onset and progression of breast cancer.

One major disadvantage to OM imaging is the poor spatial resolution that has been achieved to date. Breast cancer tumors larger than 1 centimeter are very dangerous and more likely to lead to death, so a successful screening technique must be able to resolve smaller lesions. This remains a problem with OM imaging as a stand-alone technique, but combining OM with other imaging methods shows some promise.

A possible advantage to OM, however, is that only gentle pressure need be applied to the breast tissue, in stark contrast to the standard technique for X-ray imaging. In fact, breast compression tends to reduce blood volume in the tissue, which would interfere with the OM image, so some three-dimensional OM detectors being developed use no compression at all but, rather, surround the breast tissue with rings of light sources and detectors.

While poor spatial resolution of OM methods remains a challenge, the method does show promise for use in pre-surgical chemotherapy. As Edoardo Ferocino, Politecnico di Milano, Italy, co-author of the work explains, "This technique is able to provide information on the outcome of chemotherapy just weeks after beginning treatment, or possibly even sooner." Ferocino's group is planning clinical studies to explore the use of OM to monitor and predict the outcome of chemotherapy.

The investigators in Milan are working with a larger consortium on a project known as SOLUS, "Smart Optical and Ultrasound Diagnostics of Breast Cancer." This project is funded by the European Union through the Horizon 2020 Research and Innovation Program and aims to combine optical imaging methods with ultrasound to improve specificity in the diagnosis of breast cancer. [13]

Breakthrough in photonic biosensors could lead to super-accurate diagnostic and detectors

University Professor of Applied Physics Stephen Arnold and his team at the New York University Tandon School of Engineering have made a discovery that could lead to Star Trek-like biosensor devices capable of flagging the barest presence in blood of a specific virus or antibody, or protein marker for a specific cancer; or sniffing out airborne chemical warfare agents while they are still far below toxic levels.

The discovery follows years of groundbreaking work by Arnold, who in 1995 discovered that an optical fiber could excite what he termed Whispering Gallery Mode (WGM) in silicon micro-beads less than one-third the diameter of a human hair. Further discoveries and patents led to WGM biosensors capable of gauging the mass of viruses, proteins and other nanoparticles by sending them into spacecraft-like orbit around the micro-bead, thanks to a photonic "tractor beam" caused by the resonating light. Arnold and collaborators then devised a way to make these WGM biosensors sensitive enough to identify even the smallest individual bio-particles from the RNA virus MS2 to single molecules down to 6 zepto-grams (10?21 grams), below the mass of all known cancer markers. Many companies, including Genalyte, employ WGM biosensors in diagnostic products that can perform dozens of bioassays in minutes.

Now, Arnold and his team at NYU Tandon's MicroParticle PhotoPhysics Laboratory for BioPhotonics (MP3L) are the first to find a way to determine the density of charges on an area of a WGM micro-bead's surface, as well as the charge of an ensnared nanoparticle or virus, by measuring how light frequency fluctuates as the tiny particle follows its wobbly course around the sphere. This discovery could allow researchers and manufacturers not just to identify nanoparticles, but to manipulate them.

Arnold, who also is a member of the Othmer-Jacobs Department of Chemical and Biomolecular Engineering at NYU, and his fellow researchers, including Jehovani Lopez, Eshan Treasurer, Kaitlynn Snyder, and David Keng, recently published their findings in *Applied Physics Letters*.

The WGM biosensor, which Arnold named for the famous Whispering Gallery in the dome of St. Paul's Cathedral in London, is a device the size of a small smartphone comprising a tunable laser guided down a specially treated fiber optic filament with a detector at the far end of the filament measuring the light's intensity and resonance. A tiny silica bead next to the filament diverts a portion of the light beam, which begins to resonate within the bead the way sound resonates under the dome of the church gallery for which the phenomenon is named.

While the WGM biosensor's ability to identify individual nanoparticles led to highly sensitive measuring capabilities, Arnold's latest discovery could make possible biosensors tailored to very specific applications, from wearable sensors for soldiers and rescuers designed to detect extremely low concentrations of a suspected airborne nerve agent, to ways of increasing the efficiency of nanoparticle drug uptake and redistribution.

"Charge controls the ability to transport particles that are interacting with cells and other objects that possess electric fields," he said. "By determining the charge of a virus, for example, you can understand how it can be transported to the cell surface. You need to understand this mechanism in order to engineer a WGM micro-bead that has a specific antigen at a specific region of its surface so that the biosensor can attract specific pathogens or other biomolecules."

Arnold and the MP3L team were able to extract the electrostatic force between the orbiting nanoparticle and the surface of the glass bead through experiments based on the observation that the nano-orbital phenomenon requires a near balance between the electrostatic force and the known optical tractor beam force, just as a weighing scale balances the force of a spring against your body's weight.

"The difference in the strength of the force being measured is extraordinarily small," said Arnold, who explained that the measured electrostatic force involved in keeping a nanoparticle in orbit was only 0.00000000000003 ($3x10^{-14}$) pounds. "With this force in hand both the charge on the nanoparticle and the microcavity charge density could be calculated through a series of experiments."

The team next plans to use the discovery to develop technology for "photonic printing," the ability to quickly create numerous task-specific WGM biosensors, with specific molecules attached to specific areas of the micro-bead. [12]

Scientists use diamond in world's first continuous room-temperature solid-state maser

The maser (microwave amplification by stimulated emission of radiation), the older microwave frequency sibling of the laser, was invented in 1954. However unlike lasers, which have become widespread, masers are much less widely used because in order to function they must be cooled to temperatures close to absolute zero (-273°C).

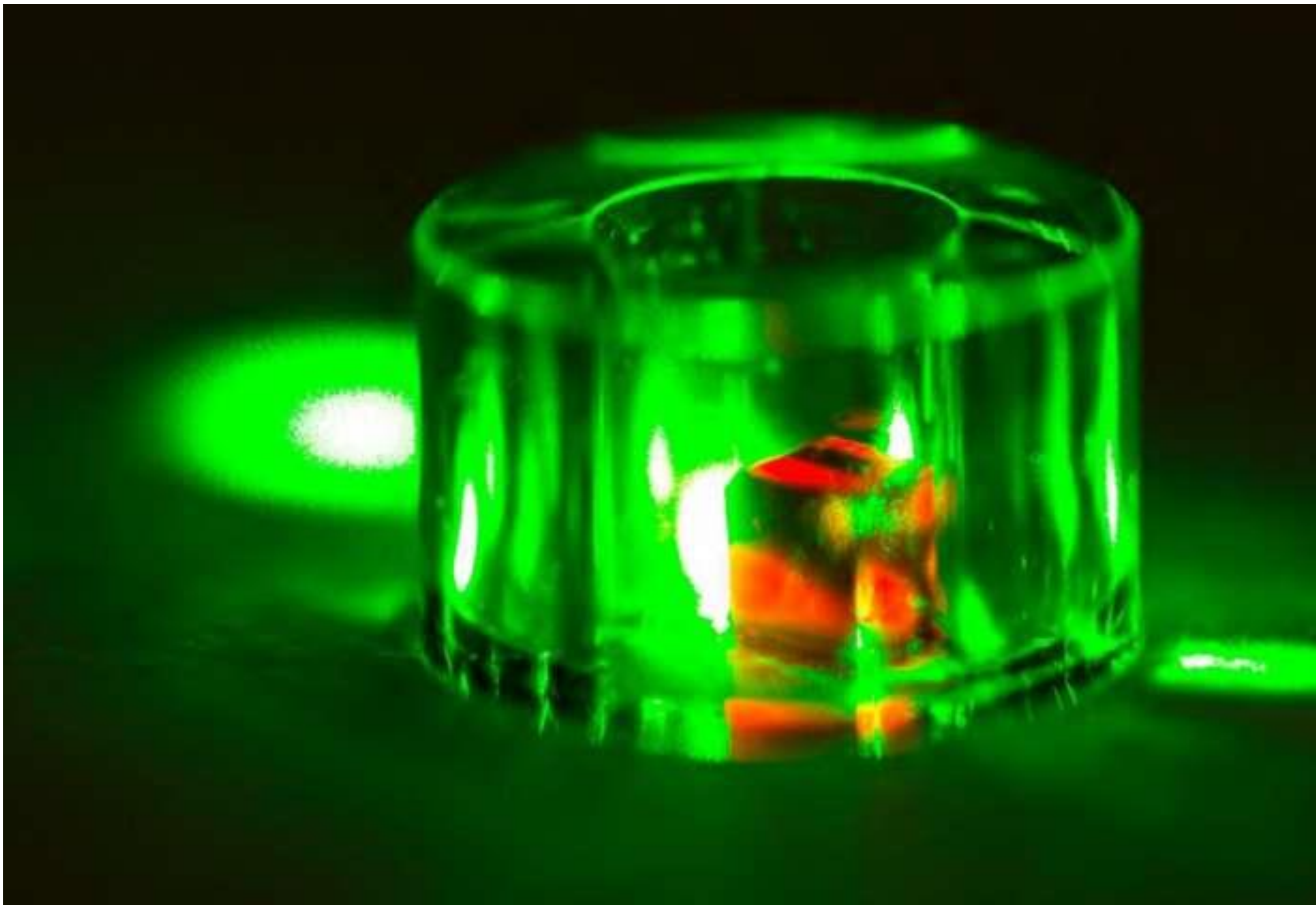
However, this new study from Imperial College London and UCL, and published in *Nature*, reports for the first time a maser that can act continuously at room temperature.

Lead researcher Dr Jonathan Breeze, from Imperial's Department of Materials, said: "This breakthrough paves the way for the widespread adoption of masers and opens the door for a wide array of applications that we are keen to explore. We hope the maser will now enjoy as much success as the laser."

In 2012, scientists demonstrated that a maser could operate at room temperature using the organic molecule pentacene. However, it only produced short bursts of maser radiation that lasted less than one thousandth of a second. In any case, had the maser operated continuously, the crystal would likely have melted.

Now, Dr Breeze and colleagues have used a synthetic diamond grown in a nitrogen-rich atmosphere to create a new maser that operates continuously.

Carbon atoms were 'knocked out' from the diamond using a high energy electron beam, creating spaces known as 'vacancies'. The diamond was then heated, which allowed nitrogen atoms and carbon vacancies to pair up, forming a type of defect known as a nitrogen-vacancy (NV) defect centre. The diamond was provided by Element Six.



The diamond is held inside a sapphire ring and illuminated by 532-nm green laser. The red light is fluorescence from the NV centres. Credit: Thomas Angus, Imperial College London

When placed inside a ring of sapphire to concentrate the microwave energy, and illuminated by green laser light, the researchers found that the maser worked at room temperature and importantly, continuously.

Co-author Professor Neil Alford, also from Imperial's Department of Materials, said: "This technology has a way to go, but I can see it being used where sensitive detection of microwave radiation is essential".

The team who made the discovery say masers could be used in a range of applications such as medical imaging and airport security scanning. They have more traditionally been used in deep space communication and radio astronomy.

As well as medical imaging and airport security scanning, masers could play a pivotal role in improving sensors to remotely detect bombs, new technology for quantum computers, and might even improve space communication methods to potentially find life on other planets. [11]

Designing diamonds for medical imaging technologies

Japanese researchers have optimized the design of laboratory-grown, synthetic diamonds. This brings the new technology one step closer to enhancing biosensing applications, such as magnetic brain imaging. The advantages of this layered, sandwichlike, diamond structure are described in a recent issue of *Applied Physics Letters*.

Chemical processes are used to create large sheets of diamonds for industrial applications. Artificial diamonds can be grown on various surfaces to increase the hardness and reduce the wear of tools, or to take advantage of diamond's high thermal conductivity as a heat sink for electronics. Scientists can manipulate the properties of artificial diamonds by altering their chemical composition. This chemical manipulation is called doping. These "doped" diamonds are proving to be a cheap alternative material for a range of technologies—from quantum information to biosensing—that would otherwise have been prohibitively expensive to develop.

Diamonds designed with nitrogen-vacancy (NV) centers that can detect changes in magnetic fields are a powerful tool for biosensing technologies and used in the medical detection and diagnosis of disease. For instance, magnetoencephalography (MEG) is a neuroimaging technique used to map brain activity and trace pathological abnormalities, such as epileptic tissue.

"MEG is commercially available and used in some hospitals but is very expensive so not many MEGs are used," said Norikazu Mizuochi, an author on the paper. Mizuochi explained that using diamonds with NV centers would reduce the equipment costs of MEG diagnoses.

However, these biosensing technologies require light activation, which induces charge switching in NV centers. Neutral NV centers are not able to accurately detect magnetic fields, so the introduction of switching remains a challenge for diamond utilization. "Only the minus [negative] charge can be used for such sensing applications, therefore stabilizing [NV] centers is important for operation," Mizuochi said.

The researchers had previously doped a simple diamond structure with phosphorus to stabilize the NV centers. Phosphorus doping pushed over 90 percent of NV centers to the negative charge state, enabling magnetic field detection. However, the phosphorus introduced noise to the readout, negating the positive result.

In this study, the team adapted the diamond design to preserve the stabilization of negative NV centers, but removed the phosphorus-induced noise. They used a layered structure, like a sandwich, with phosphorus doped diamond as the bread, and enclosed a 10µm thick NV-center diamond filling. This stabilized 70-80 percent of NV centers in the negative charge state, while reducing the noise previously seen in the system.

"At the moment, we have just demonstrated stabilization, but we expect it to also improve sensitivity," Mizuochi said. His team is currently testing the sensitivity of the new design to changes in magnetic fields, and hoping that this structure could be used for biosensing applications such as MEG. [10]

Experiment demonstrates quantum mechanical effects from biological systems

Nearly 75 years ago, Nobel Prize-winning physicist Erwin Schrödinger wondered if the mysterious world of quantum mechanics played a role in biology. A recent finding by Northwestern University's Prem Kumar adds further evidence that the answer might be yes.
Kumar and his team have, for the first time, created quantum entanglement from a biological system. This finding could advance scientists' fundamental understanding of biology and potentially open doors to exploit biological tools to enable new functions by harnessing quantum mechanics.

"Can we apply quantum tools to learn about biology?" said Kumar, professor of electrical engineering and computer science in Northwestern's McCormick School of Engineering and of physics and astronomy in the Weinberg College of Arts and Sciences. "People have asked this question for many, many years—dating back to the dawn of quantum mechanics. The reason we are interested in these new quantum states is because they allow applications that are otherwise impossible."

Partially supported by the Defense Advanced Research Projects Agency, the research was published Dec. 5 in *Nature Communications*.

Quantum entanglement is one of quantum mechanics' most mystifying phenomena. When two particles—such as atoms, photons, or electrons—are entangled, they experience an inexplicable link that is maintained even if the particles are on opposite sides of the universe. While entangled, the particles' behavior is tied one another. If one particle is found spinning in one direction, for example, then the other particle instantaneously changes its spin in a corresponding manner dictated by the entanglement. Researchers, including Kumar, have been interested in harnessing quantum entanglement for several applications, including quantum communications. Because the particles can communicate without wires or cables, they could be used to send secure messages or help build an extremely fast "quantum Internet."

"Researchers have been trying to entangle a larger and larger set of atoms or photons to develop substrates on which to design and build a quantum machine," Kumar said. "My laboratory is asking if we can build these machines on a biological substrate."

In the study, Kumar's team used green fluorescent proteins, which are responsible for bioluminescence and commonly used in biomedical research. The team attempted to entangle the photons generated from the fluorescing molecules within the algae's barrel-shaped protein structure by exposing them to spontaneous four-wave mixing, a process in which multiple wavelengths interact with one another to produce new wavelengths.

Through a series of these experiments, Kumar and his team successfully demonstrated a type of entanglement, called polarization entanglement, between photon pairs. The same feature used to make glasses for viewing 3D movies, polarization is the orientation of oscillations in light waves. A wave can oscillate vertically, horizontally, or at different angles. In Kumar's entangled pairs, the photons' polarizations are entangled, meaning that the oscillation directions of light waves are linked. Kumar also noticed that the barrel-shaped structure surrounding the fluorescing molecules protected the entanglement from being disrupted.

"When I measured the vertical polarization of one particle, we knew it would be the same in the other," he said. "If we measured the horizontal polarization of one particle, we could predict the horizontal polarization in the other particle. We created an entangled state that correlated in all possibilities simultaneously."

Now that they have demonstrated that it's possible to create quantum entanglement from biological particles, next Kumar and his team plan to make a biological substrate of entangled particles, which could be used to build a quantum machine. Then, they will seek to understand if a biological substrate works more efficiently than a synthetic one. [9]

Quantum biology: Algae evolved to switch quantum coherence on and off

A UNSW Australia-led team of researchers has discovered how algae that survive in very low levels of light are able to switch on and off a weird quantum phenomenon that occurs during photosynthesis.

The function in the algae of this quantum effect, known as coherence, remains a mystery, but it is thought it could help them harvest energy from the sun much more efficiently. Working out its role in a living organism could lead to technological advances, such as better organic solar cells and quantum-based electronic devices.

The research is published in the journal Proceedings of the National Academy of Sciences.

It is part of an emerging field called quantum biology, in which evidence is growing that quantum phenomena are operating in nature, not just the laboratory, and may even account for how birds can navigate using the earth's magnetic field.

"We studied tiny single-celled algae called cryptophytes that thrive in the bottom of pools of water, or under thick ice, where very little light reaches them," says senior author, Professor Paul Curmi, of the UNSW School of Physics.

"Most cryptophytes have a light-harvesting system where quantum coherence is present. But we have found a class of cryptophytes where it is switched off because of a genetic mutation that alters the shape of a light-harvesting protein.

"This is a very exciting find. It means we will be able to uncover the role of quantum coherence in photosynthesis by comparing organisms with the two different types of proteins."

In the weird world of quantum physics, a system that is coherent – with all quantum waves in step with each other – can exist in many different states simultaneously, an effect known as superposition. This phenomenon is usually only observed under tightly controlled laboratory conditions.

So the team, which includes Professor Gregory Scholes from the University of Toronto in Canada, was surprised to discover in 2010 that the transfer of energy between molecules in the light harvesting systems from two different cryptophyte species was coherent.

The same effect has been found in green sulphur bacteria that also survive in very low light levels.

"The assumption is that this could increase the efficiency of photosynthesis, allowing the algae and bacteria to exist on almost no light," says Professor Curmi.

"Once a light-harvesting protein has captured sunlight, it needs to get that trapped energy to the reaction centre in the cell as quickly as possible, where the energy is converted into chemical energy for the organism.

"It was assumed the energy gets to the reaction centre in a random fashion, like a drunk staggering home. But quantum coherence would allow the energy to test every possible pathway simultaneously before travelling via the quickest route."

In the new study, the team used x-ray crystallography to work out the crystal structure of the lightharvesting complexes from three different species of cryptophytes.

They found that in two species a genetic mutation has led to the insertion of an extra amino acid that changes the structure of the protein complex, disrupting coherence.

"This shows cryptophytes have evolved an elegant but powerful genetic switch to control coherence and change the mechanisms used for light harvesting," says Professor Curmi.

The next step will be to compare the biology of different cryptophytes, such as whether they inhabit different environmental niches, to work out whether the quantum coherence effect is assisting their survival. [8]

Photoactive Prebiotic Systems

We propose that life first emerged in the form of such minimal photoactive prebiotic kernel systems and later in the process of evolution these photoactive prebiotic kernel systems would have produced fatty acids and covered themselves with fatty acid envelopes to become the minimal cells of the Fatty Acid World. Specifically, we model self-assembling of photoactive prebiotic systems with observed quantum entanglement phenomena. We address the idea that quantum entanglement was important in the first stages of origins of life and evolution of the biospheres because simultaneously excite two prebiotic kernels in the system by appearance of two additional quantum entangled excited states, leading to faster growth and self-replication of minimal living cells. The quantum mechanically modeled possibility of synthesizing artificial selfreproducing quantum entangled prebiotic kernel systems and minimal cells also impacts the possibility of the most probable path of emergence of photocells on the Earth or elsewhere. We also examine the quantum entangled logic gates discovered in the modeled systems composed of two prebiotic kernels. Such logic gates may have application in the destruction of cancer cells or becoming building blocks of new forms of artificial cells including magnetically active ones.

Significance Statement

Our investigated self-assembly of molecules towards supramolecular bioorganic and minimal cellular systems depends on the quantum mechanics laws which induce hydrogen and Van der Waals bindings (Tamulis A, Grigalavicius, M, Orig Life Evol Biosph 41:51-71, 2011).

In the work presented here, quantum entanglement takes the form of a quantum superposition of the active components in synthesized self-assembling and self-replicating living systems. When a quantum calculation of an entangled system is made that causes one photoactive biomolecule of such a pair to take on a definite value (e.g., electron density transfer or electron spin density transfer), the other member of this entangled pair will be found to have taken the appropriately correlated value (e.g., electron density transfer or electron spin density transfer). In our simulations, the separation distance of supramolecular bio systems changes took place during geometry optimization procedures, which mimic real-world intermolecular interaction processes.

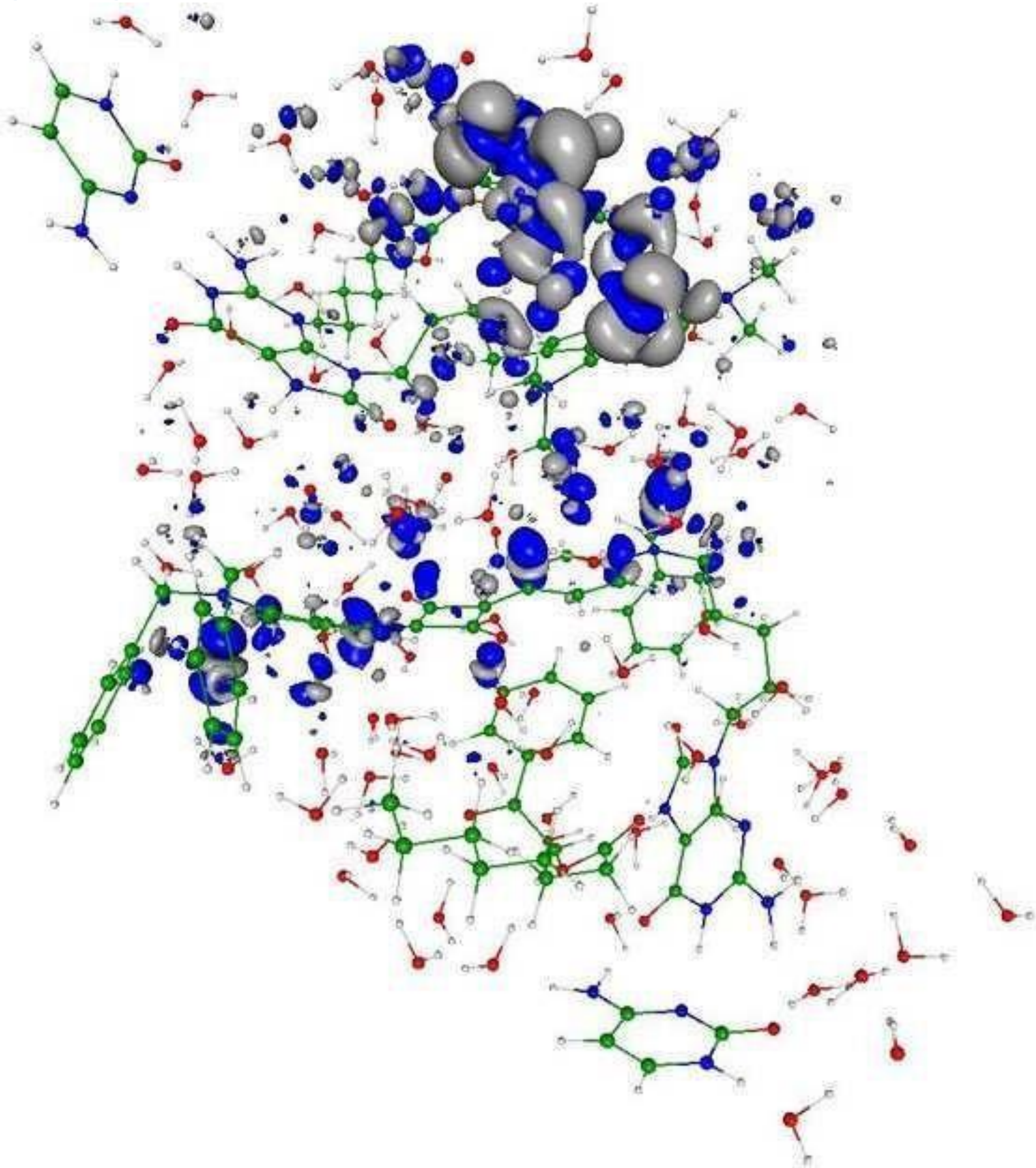
Our discovered phenomenon of the quantum entanglement in the prebiotic systems enhance the photosynthesis in the proposed systems because simultaneously excite two prebiotic kernels in the system by appearance of two additional quantum entangled excited states (Tamulis A, Grigalavicius M, Baltrusaitis J, Orig Life Evol Biosph 43:49-66, 2013; Tamulis A, Grigalavicius M, Krisciukaitis S (2014) , J Comput Theor Nanos, 11, 1597-1608, 2014; Tamulis A, Grigalavicius M, 8:117-140, 2014.). We can propose that quantum entanglement enhanced the emergence of photosynthetic prebiotic kernels and accelerated the evolution of photosynthetic life because of additional absorbed light energy, leading to faster growth and self-replication of minimal living cells.

We can state that: Livings are self-assembled and self-replicating wet and warm stochastically moving supramolecular systems where quantum entanglement can be continuously generated and destroyed by non-equilibrium effects in an environment where no static entanglement exists; quantum entanglement involve the biomolecule inside one living or between other neighboring livings.

This warm quantum coherence is basic for the explanation of DNA stability and for the understanding of brain magnetic orientation during migration in more than 50 species of birds, fishes and insects. Exists experimental evidence for quantum-coherent is used for more efficient light-harvesting in plant photosynthesis. Quantum entanglement exists in supramolecules determining the sense of smell and in the brain neurons microtubules due to quantum vibrations.

In the work presented here, we started to design and quantum mechanical investigations of the molecular logical devices which are useful for construction of nano medicine biorobots against the molecular diseases such a cancer tumors, and against the new kinds of synthesized microorganisms and nano guns.

Figure legend



You can see in the enclosed figure the quantum entanglement phenomenon in the closely selfassembled two synthesized protocell system due to the photo excited electron charge transfer from one protocell to another that leads to closer self-assembly and exchange of energy and information.

Visualization of the electron charge tunneling associated with the 6th (467.3 nm) excited state. The transition is mainly from squarine molecule of the first protocell situated in the bottom of this bi cellular system to precursor of fatty acid (pFA) molecule of the second subsystem (in the top) and little from the 1,4-bis(N,N-dimethylamino)naphthalene molecule (in the top-right) to the same pFA molecule of the second subsystem (in the top). The electron cloud hole is indicated by the dark blue color while the transferred electron cloud location is designated by the gray color.

As a result, these nonlinear quantum interactions compressed the overall molecular system resulting in a smaller gap between the HOMO and LUMO electron energy levels which allows enhanced tunneling of photo excited electrons from the sensitizer squarine and (1,4bis(N,Ndimethylamino)naphthalene) to the pFA molecule resulting in its cleavage. The new fatty acid joins the existing minimal cell thus increasing it in size. After reaching some critical size, the minimal cell should divide (i.e. self-replicate) into two separate smaller minimal cells. [7]

Quantum Biology

Researchers have long suspected that something unusual is afoot in photosynthesis. Particles of light called photons, streaming down from the Sun; arrive randomly at the chlorophyll molecules and other light-absorbing 'antenna' pigments that cluster inside the cells of every leaf, and within every photosynthetic bacterium. But once the photons' energy is deposited, it doesn't stay random. Somehow, it gets channeled into a steady flow towards the cell's photosynthetic reaction centre, which can then use it at maximum efficiency to convert carbon dioxide into sugars. Quantum coherence in photosynthesis seems to be beneficial to the organisms using it. But did their ability to exploit quantum effects evolve through natural selection? Or is quantum coherence just an accidental side effect of the way certain molecules are structured? [6]

Quantum Consciousness

Extensive scientific investigation has found that a form of quantum coherence operates within living biological systems through what is known as biological excitations and biophoton emission. What this means is that metabolic energy is stored as a form of electromechanical and electromagnetic excitations. These coherent excitations are considered responsible for generating and maintaining long-range order via the transformation of energy and very weak electromagnetic signals. After nearly twenty years of experimental research, Fritz-Albert Popp put forward the hypothesis that biophotons are emitted from a coherent electrodynamics field within the living system.

What this means is that each living cell is giving off, or resonating, a biophoton field of coherent energy. If each cell is emitting this field, then the whole living system is, in effect, a resonating field-a ubiquitous nonlocal field. And since biophotons are the entities through which the living system communicates, there is near-instantaneous intercommunication throughout. And this, claims Popp, is the basis for coherent biological organization -- referred to as quantum coherence. This discovery led Popp to state that the capacity for evolution rests not on aggressive struggle and rivalry but on the capacity for communication and cooperation. In this sense the built-in capacity for species evolution is not based on the individual but rather living systems that are interlinked within a coherent whole: Living systems are thus neither the subjects alone, nor objects isolated, but both subjects and objects in a mutually communicating universe of meaning. . . . Just as the cells in an organism take on different tasks for the whole, different populations enfold information not only for themselves, but for all other organisms, expanding the consciousness of the whole, while at the same time becoming more and more aware of this collective consciousness.

Biophysicist Mae-Wan Ho describes how the living organism, including the human body, is coordinated throughout and is "coherent beyond our wildest dreams." It appears that every part of our body is "in communication with every other part through a dynamic, tunable, responsive, liquid crystalline medium that pervades the whole body, from organs and tissues to the interior of every cell."

What this tells us is that the medium of our bodies is a form of liquid crystal, an ideal transmitter of communication, resonance, and coherence. These relatively new developments in biophysics have discovered that all biological organisms are constituted of a liquid crystalline medium. Further, DNA is a liquid-crystal, lattice-type structure (which some refer to as a liquid crystal gel), whereby body cells are involved in a holographic instantaneous communication via the emitting of biophotons (a source based on light). This implies that all living biological organisms continuously emit radiations of light that form a field of coherence and communication. Moreover, biophysics has discovered that living organisms are permeated by quantum wave forms. [5]

Creating quantum technology

Another area of potential application is in quantum computing. The long-standing goal of the physicists and engineers working in this area is to manipulate data encoded in quantum bits (qubits) of information, such as the spin-up and spin-down states of an electron or of an atomic nucleus. Qubits can exist in both states at once, thus permitting the simultaneous exploration of all possible answers to the computation that they encode. In principle, this would give quantum computers the power to find the best solution far more quickly than today's computers can — but only if the qubits can maintain their coherence, without the noise of the surrounding environment, such as the jostling of neighboring atoms, destroying the synchrony of the waves. [6]

Quantum Entanglement

Measurements of physical properties such as position, momentum, spin, polarization, etc. performed on entangled particles are found to be appropriately correlated. For example, if a pair of particles is generated in such a way that their total spin is known to be zero, and one particle is found to have clockwise spin on a certain axis, then the spin of the other particle, measured on the same axis, will be found to be counterclockwise. Because of the nature of quantum measurement, however, this behavior gives rise to effects that can appear paradoxical: any measurement of a property of a particle can be seen as acting on that particle (e.g. by collapsing a number of superimposed states); and in the case of entangled particles, such action must be on the entangled system as a whole. It thus appears that one particle of an entangled pair "knows" what measurement has been performed on the other, and with what outcome, even though there is no known means for such information to be communicated between the particles, which at the time of measurement may be separated by arbitrarily large distances. [4]

The Bridge

The accelerating electrons explain not only the Maxwell Equations and the Special Relativity, but the Heisenberg Uncertainty Relation, the wave particle duality and the electron's spin also, building the bridge between the Classical and Quantum Theories. [1]

Accelerating charges

The moving charges are self maintain the electromagnetic field locally, causing their movement and this is the result of their acceleration under the force of this field. In the classical physics the charges will distributed along the electric current so that the electric potential lowering along the current, by linearly increasing the way they take every next time period because this accelerated motion. The same thing happens on the atomic scale giving a dp impulse difference and a dx way difference between the different part of the not point like particles.

Relativistic effect

Another bridge between the classical and quantum mechanics in the realm of relativity is that the charge distribution is lowering in the reference frame of the accelerating charges linearly: ds/dt = at (time coordinate), but in the reference frame of the current it is parabolic: $s = a/2\ t^2$ (geometric coordinate).

Heisenberg Uncertainty Relation

In the atomic scale the Heisenberg uncertainty relation gives the same result, since the moving electron in the atom accelerating in the electric field of the proton, causing a charge distribution on delta x position difference and with a delta p momentum difference such a way that they product is about the half Planck reduced constant. For the proton this delta x much less in the nucleon, than in the orbit of the electron in the atom, the delta p is much higher because of the greater proton mass.

This means that the electron and proton are not point like particles, but has a real charge distribution.

Wave – Particle Duality

The accelerating electrons explains the wave – particle duality of the electrons and photons, since the elementary charges are distributed on delta x position with delta p impulse and creating a wave packet of the electron. The photon gives the electromagnetic particle of the mediating force of the electrons electromagnetic field with the same distribution of wavelengths.

Atomic model

The constantly accelerating electron in the Hydrogen atom is moving on the equipotential line of the proton and it's kinetic and potential energy will be constant. Its energy will change only when it is changing its way to another equipotential line with another value of potential energy or getting free with enough kinetic energy. This means that the Rutherford-Bohr atomic model is right and only that changing acceleration of the electric charge causes radiation, not the steady acceleration. The steady acceleration of the charges only creates a centric parabolic steady electric field around the charge, the magnetic field. This gives the magnetic moment of the atoms, summing up the proton and electron magnetic moments caused by their circular motions and spins.

The Relativistic Bridge

Commonly accepted idea that the relativistic effect on the particle physics it is the fermions' spin - another unresolved problem in the classical concepts. If the electric charges can move only with accelerated motions in the self maintaining electromagnetic field, once upon a time they would reach the velocity of the electromagnetic field. The resolution of this problem is the spinning particle, constantly accelerating and not reaching the velocity of light because the acceleration is radial. One origin of the Quantum Physics is the Planck Distribution Law of the electromagnetic oscillators, giving equal intensity for 2 different wavelengths on any temperature. Any of these two wavelengths will give equal intensity diffraction patterns, building different asymmetric constructions, for example proton - electron structures (atoms), molecules, etc. Since the particles are centers of diffraction patterns they also have particle – wave duality as the electromagnetic waves have. [2]

The weak interaction

The weak interaction transforms an electric charge in the diffraction pattern from one side to the other side, causing an electric dipole momentum change, which violates the CP and time reversal symmetry. The Electroweak Interaction shows that the Weak Interaction is basically electromagnetic in nature. The arrow of time shows the entropy grows by changing the temperature dependent diffraction patterns of the electromagnetic oscillators.

Another important issue of the quark model is when one quark changes its flavor such that a linear oscillation transforms into plane oscillation or vice versa, changing the charge value with 1 or -1. This kind of change in the oscillation mode requires not only parity change, but also charge and time changes (CPT symmetry) resulting a right handed anti-neutrino or a left handed neutrino.

The right handed anti-neutrino and the left handed neutrino exist only because changing back the quark flavor could happen only in reverse, because they are different geometrical constructions, the u is 2 dimensional and positively charged and the d is 1 dimensional and negatively charged. It needs also a time reversal, because anti particle (anti neutrino) is involved.

The neutrino is a 1/2spin creator particle to make equal the spins of the weak interaction, for example neutron decay to 2 fermions, every particle is fermions with ½ spin. The weak interaction changes the entropy since more or less particles will give more or less freedom of movement. The entropy change is a result of temperature change and breaks the equality of oscillator diffraction intensity of the Maxwell–Boltzmann statistics. This way it changes the time coordinate measure and makes possible a different time dilation as of the special relativity.

The limit of the velocity of particles as the speed of light appropriate only for electrical charged particles, since the accelerated charges are self maintaining locally the accelerating electric force. The neutrinos are CP symmetry breaking particles compensated by time in the CPT symmetry, that is the time coordinate not works as in the electromagnetic interactions, consequently the speed of neutrinos is not limited by the speed of light.

The weak interaction T-asymmetry is in conjunction with the T-asymmetry of the second law of thermodynamics, meaning that locally lowering entropy (on extremely high temperature) causes the

weak interaction, for example the Hydrogen fusion.

Probably because it is a spin creating movement changing linear oscillation to 2 dimensional oscillation by changing d to u quark and creating anti neutrino going back in time relative to the proton and electron created from the neutron, it seems that the anti neutrino fastest then the velocity of the photons created also in this weak interaction?

A quark flavor changing shows that it is a reflection changes movement and the CP- and T-symmetry breaking!!! This flavor changing oscillation could prove that it could be also on higher level such as atoms, molecules, probably big biological significant molecules and responsible on the aging of the life.

Important to mention that the weak interaction is always contains particles and antiparticles, where the neutrinos (antineutrinos) present the opposite side. It means by Feynman's interpretation that these particles present the backward time and probably because this they seem to move faster than the speed of light in the reference frame of the other side.

Finally since the weak interaction is an electric dipole change with ½ spin creating; it is limited by the velocity of the electromagnetic wave, so the neutrino's velocity cannot exceed the velocity of light.

The General Weak Interaction

The Weak Interactions T-asymmetry is in conjunction with the T-asymmetry of the Second Law of Thermodynamics, meaning that locally lowering entropy (on extremely high temperature) causes for example the Hydrogen fusion. The arrow of time by the Second Law of Thermodynamics shows the increasing entropy and decreasing information by the Weak Interaction, changing the temperature dependent diffraction patterns. A good example of this is the neutron decay, creating more particles with less known information about them.

The neutrino oscillation of the Weak Interaction shows that it is a general electric dipole change and it is possible to any other temperature dependent entropy and information changing diffraction pattern of atoms, molecules and even complicated biological living structures. We can generalize the weak interaction on all of the decaying matter constructions, even on the biological too. This gives the limited lifetime for the biological constructions also by the arrow of time. There should be a new research space of the Quantum Information Science the 'general neutrino oscillation' for the greater then subatomic matter structures as an electric dipole change.

There is also connection between statistical physics and evolutionary biology, since the arrow of time is working in the biological evolution also.
The Fluctuation Theorem says that there is a probability that entropy will flow in a direction opposite to that dictated by the Second Law of Thermodynamics. In this case the Information is growing that is the matter formulas are emerging from the chaos. So the Weak Interaction has two directions, samples for one direction is the Neutron decay, and Hydrogen fusion is the opposite direction.

Fermions and Bosons

The fermions are the diffraction patterns of the bosons such a way that they are both sides of the same thing.

Van Der Waals force

Named after the Dutch scientist Johannes Diderik van der Waals – who first proposed it in 1873 to explain the behaviour of gases – it is a very weak force that only becomes relevant when atoms and molecules are very close together. Fluctuations in the electronic cloud of an atom mean that it will have an instantaneous dipole moment. This can induce a dipole moment in a nearby atom, the result being an attractive dipole–dipole interaction.

Electromagnetic inertia and mass

Electromagnetic Induction

Since the magnetic induction creates a negative electric field as a result of the changing acceleration, it works as an electromagnetic inertia, causing an electromagnetic mass. [1]

Relativistic change of mass

The increasing mass of the electric charges the result of the increasing inductive electric force acting against the accelerating force. The decreasing mass of the decreasing acceleration is the result of the inductive electric force acting against the decreasing force. This is the relativistic mass change explanation, especially importantly explaining the mass reduction in case of velocity decrease.

The frequency dependence of mass

Since $\boldsymbol{E = hv}$ and $\boldsymbol{E = mc^2}$, $\boldsymbol{m = hv / c^2}$ that is the $\boldsymbol{m}$ depends only on the $\boldsymbol{v}$ frequency. It means that the mass of the proton and electron are electromagnetic and the result of the electromagnetic induction, caused by the changing acceleration of the spinning and moving charge! It could be that the $\boldsymbol{m_o}$ inertial mass is the result of the spin, since this is the only accelerating motion of the electric charge. Since the accelerating motion has different frequency for the electron in the atom and the proton, they masses are different, also as the wavelengths on both sides of the diffraction pattern, giving equal intensity of radiation.

Electron – Proton mass rate

The Planck distribution law explains the different frequencies of the proton and electron, giving equal intensity to different lambda wavelengths! Also since the particles are diffraction patterns they have some closeness to each other – can be seen as a gravitational force. [2]

There is an asymmetry between the mass of the electric charges, for example proton and electron, can understood by the asymmetrical Planck Distribution Law. This temperature dependent energy distribution is asymmetric around the maximum intensity, where the annihilation of matter and antimatter is a high probability event. The asymmetric sides are creating different frequencies of electromagnetic radiations being in the same intensity level and compensating each other. One of these compensating ratios is the electron – proton mass ratio. The lower energy side has no compensating intensity level, it is the dark energy and the corresponding matter is the dark matter.

Gravity from the point of view of quantum physics

The Gravitational force

The gravitational attractive force is basically a magnetic force.

The same electric charges can attract one another by the magnetic force if they are moving parallel in the same direction. Since the electrically neutral matter is composed of negative and positive charges they need 2 photons to mediate this attractive force, one per charges. The Bing Bang caused parallel moving of the matter gives this magnetic force, experienced as gravitational force.

Since graviton is a tensor field, it has spin = 2, could be 2 photons with spin = 1 together.

You can think about photons as virtual electron – positron pairs, obtaining the necessary virtual mass for gravity.

The mass as seen before a result of the diffraction, for example the proton – electron mass rate Mp=1840 Me. In order to move one of these diffraction maximum (electron or proton) we need to intervene into the diffraction pattern with a force appropriate to the intensity of this diffraction maximum, means its intensity or mass.

The Big Bang caused acceleration created radial currents of the matter, and since the matter is composed of negative and positive charges, these currents are creating magnetic field and attracting forces between the parallel moving electric currents. This is the gravitational force experienced by the matter, and also the mass is result of the electromagnetic forces between the charged particles. The positive and negative charged currents attracts each other or by the magnetic forces or by the much stronger electrostatic forces!?

The gravitational force attracting the matter, causing concentration of the matter in a small space and leaving much space with low matter concentration: dark matter and energy.
There is an asymmetry between the mass of the electric charges, for example proton and electron, can understood by the asymmetrical Planck Distribution Law. This temperature dependent energy

distribution is asymmetric around the maximum intensity, where the annihilation of matter and antimatter is a high probability event. The asymmetric sides are creating different frequencies of electromagnetic radiations being in the same intensity level and compensating each other. One of these compensating ratios is the electron – proton mass ratio. The lower energy side has no compensating intensity level, it is the dark energy and the corresponding matter is the dark matter.

The Higgs boson

By March 2013, the particle had been proven to behave, interact and decay in many of the expected ways predicted by the Standard Model, and was also tentatively confirmed to have + parity and zero spin, two fundamental criteria of a Higgs boson, making it also the first known scalar particle to be discovered in nature, although a number of other properties were not fully proven and some partial results do not yet precisely match those expected; in some cases data is also still awaited or being analyzed.

Since the Higgs boson is necessary to the W and Z bosons, the dipole change of the Weak interaction and the change in the magnetic effect caused gravitation must be conducted. The Wien law is also important to explain the Weak interaction, since it describes the T_{max} change and the diffraction patterns change. [2]

Higgs mechanism and Quantum Gravity

The magnetic induction creates a negative electric field, causing an electromagnetic inertia. Probably it is the mysterious Higgs field giving mass to the charged particles? We can think about the photon as an electron-positron pair, they have mass. The neutral particles are built from negative and positive charges, for example the neutron, decaying to proton and electron. The wave – particle duality makes sure that the particles are oscillating and creating magnetic induction as an inertial mass, explaining also the relativistic mass change. Higher frequency creates stronger magnetic induction, smaller frequency results lesser magnetic induction. It seems to me that the magnetic induction is the secret of the Higgs field.

In particle physics, the Higgs mechanism is a kind of mass generation mechanism, a process that gives mass to elementary particles. According to this theory, particles gain mass by interacting with the Higgs field that permeates all space. More precisely, the Higgs mechanism endows gauge bosons in a gauge theory with mass through absorption of Nambu–Goldstone bosons arising in spontaneous symmetry breaking.

The simplest implementation of the mechanism adds an extra Higgs field to the gauge theory. The spontaneous symmetry breaking of the underlying local symmetry triggers conversion of components of this Higgs field to Goldstone bosons which interact with (at least some of) the other fields in the theory, so as to produce mass terms for (at least some of) the gauge bosons. This mechanism may also leave behind elementary scalar (spin-0) particles, known as Higgs bosons.

In the Standard Model, the phrase "Higgs mechanism" refers specifically to the generation of masses for the $W^{\pm}$, and Z weak gauge bosons through electroweak symmetry breaking. The Large Hadron Collider at CERN announced results consistent with the Higgs particle on July 4, 2012 but stressed that further testing is needed to confirm the Standard Model.

What is the Spin?

So we know already that the new particle has spin zero or spin two and we could tell which one if we could detect the polarizations of the photons produced. Unfortunately this is difficult and neither ATLAS nor CMS are able to measure polarizations. The only direct and sure way to confirm that the particle is indeed a scalar is to plot the angular distribution of the photons in the rest frame of the centre of mass. A spin zero particles like the Higgs carries no directional information away from the original collision so the distribution will be even in all directions. This test will be possible when a much larger number of events have been observed. In the mean time we can settle for less certain indirect indicators.

The Graviton

In physics, the graviton is a hypothetical elementary particle that mediates the force of gravitation in the framework of quantum field theory. If it exists, the graviton is expected to be massless (because the gravitational force appears to have unlimited range) and must be a spin-2 boson. The spin follows from the fact that the source of gravitation is the stress-energy tensor, a second-rank tensor (compared to electromagnetism's spin-1 photon, the source of which is the four-current, a first-rank tensor). Additionally, it can be shown that any massless spin-2 field would give rise to a force indistinguishable from gravitation, because a massless spin-2 field must couple to (interact with) the stress-energy tensor in the same way that the gravitational field does. This result suggests that, if a massless spin-2 particle is discovered, it must be the graviton, so that the only experimental verification needed for the graviton may simply be the discovery of a massless spin-2 particle. [3]

Conclusions

Exists experimental evidence for quantum-coherent is used for more efficient light-harvesting in plant photosynthesis. Quantum entanglement exists in supramolecules determining the sense of smell and in the brain neurons microtubules due to quantum vibrations.

In the work presented here, we started to design and quantum mechanical investigations of the molecular logical devices which are useful for construction of nano medicine biorobots against the molecular diseases such a cancer tumors, and against the new kinds of synthesized microorganisms and nano guns. [7]

One of the most important conclusions is that the electric charges are moving in an accelerated way and even if their velocity is constant, they have an intrinsic acceleration anyway, the so called spin, since they need at least an intrinsic acceleration to make possible they movement .

The accelerated charges self-maintaining potential shows the locality of the relativity, working on the quantum level also. [1]

The bridge between the classical and quantum theory is based on this intrinsic acceleration of the spin, explaining also the Heisenberg Uncertainty Principle. The particle – wave duality of the electric charges and the photon makes certain that they are both sides of the same thing. The

Secret of Quantum Entanglement that the particles are diffraction patterns of the

electromagnetic waves and this way their quantum states every time is the result of the quantum state of the intermediate electromagnetic waves. [2]
These relatively new developments in biophysics have discovered that all biological organisms are constituted of a liquid crystalline medium. Further, DNA is a liquid-crystal, lattice-type structure (which some refer to as a liquid crystal gel), whereby body cells are involved in a holographic instantaneous communication via the emitting of biophotons (a source based on light). This implies that all living biological organisms continuously emit radiations of light that form a field of coherence and communication. Moreover, biophysics has discovered that living organisms are permeated by quantum wave forms. [5]
Basing the gravitational force on the accelerating Universe caused magnetic force and the Planck Distribution Law of the electromagnetic waves caused diffraction gives us the basis to build a Unified Theory of the physical interactions also.

References

[1] The Magnetic field of the Electric current and the Magnetic induction

http://academia.edu/3833335/The_Magnetic_field_of_the_Electric_current

[2] 3 Dimensional String Theory http://academia.edu/3834454/3_Dimensional_String_Theory

[3] Graviton Production By Two Photon and Electron-Photon Processes In Kaluza-Klein Theories With
Large Extra Dimensions http://arxiv.org/abs/hep-ph/9909392

[4] Quantum Entanglement

http://en.wikipedia.org/wiki/Quantum_entanglemen

t

[5] Quantum Consciousness

https://realitysandwich.com/155783/quantum_consciousness_0/

[6] Quantum Biology http://www.nature.com/news/2011/110615/pdf/474272a.pdf [7]

Quantum entanglement in photoactive prebiotic systems

https://globalmedicaldiscovery.com/key-drug-discovery-articles/quantum-entanglementphotoactive-prebiotic-systems/
[8] Quantum biology: Algae evolved to switch quantum coherence on and off

http://phys.org/news/2014-06-quantum-biology-algae-evolved-coherence.html

[9] Experiment demonstrates quantum mechanical effects from biological systems

https://phys.org/news/2017-12-quantum-mechanical-effects-biological.html

[10] Designing diamonds for medical imaging technologies

https://phys.org/news/2018-03-diamonds-medical-imaging-technologies.html

[11] Scientists use diamond in world's first continuous room-temperature solid-state maser

https://phys.org/news/2018-03-scientists-diamond-world-room-temperature-solid-state.html

[12] Breakthrough in photonic biosensors could lead to super-accurate diagnostic and detectors

https://phys.org/news/2018-03-breakthrough-photonic-biosensors-super-accurate-diagnostic.html

[13] Diagnosing breast cancer using red light

https://phys.org/news/2018-03-breast-cancer-red.html

[14] Laser ultrasound enables diagnoses at a distance

https://physicsworld.com/a/laser-ultrasound-enables-diagnoses-at-a-distance/

[15] A sound boost to extreme laser performance

https://phys.org/news/2020-03-boost-extreme-laser.html

[16] A theoretical approach to understand the mechanisms of 3-D spatiotemporal mode-locking

https://phys.org/news/2020-03-theoretical-approach-mechanisms-d-spatiotemporal.html